

**Trace Element Analysis  
of Geological, Biological &  
Environmental Materials  
By Neutron Activation Analysis:  
An Exposure**

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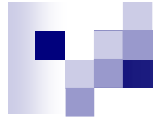
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## Session 2

- **Review of some concepts from Session 1**
- **Gamma Detection – Instrumentation Concepts**
- **Neutron Activation Analysis – Applications: Trace Element Analysis of Geological, Biological, Environmental and Industrial Materials**
- **Presentation and report assignment (one per student): Epithermal, Delayed Neutron, Prompt Gamma Neutron Activation Analysis Essay (Report)**



# **Neutron Activation Analysis – Applications:**

## **Trace Element Analysis of Geological, Biological and Environmental Materials**



## Applications:

1. Fluorine in cloth used in furniture industry.

$^{19}\text{F}(n,\gamma)^{20}\text{F}$  (1.63 MeV; 11.56 s T<sub>1/2</sub>) about  
1000 ppm

2. Fluorine in petroleum refining industry.

Petroleum companies use refining techniques which using HF, in which F should not exceed  
0.01 ppm



# Applications: ...

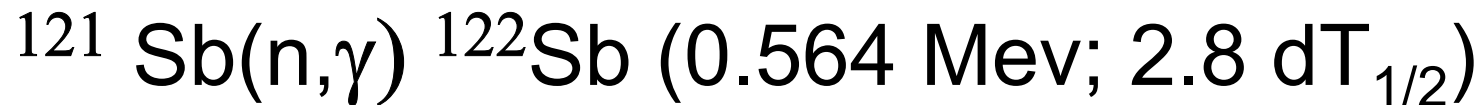
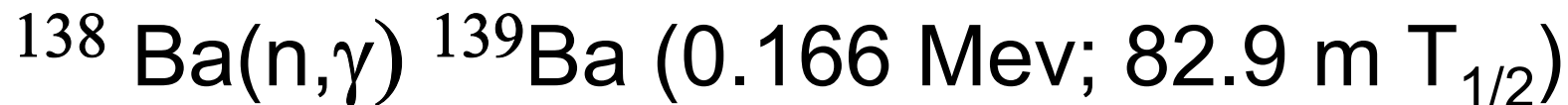
## 3. Vanadium in crude oil:

$^{51}\text{V}(n,\gamma)^{52}\text{V}$  (1.434 Mev; 4 m T<sub>1/2</sub>)

1 ppm to 0.1 ppb

# Applications: ...

4. Ba and Sb in forensic investigation.  
Determination of Ba and Sb in gunshot residues involves chemistry to dissolve samples lifted off the scene with paraffin wax.



Also, a radioactive tracer is used.



# Applications: ...

5. Sb in bullet manufacturing.

0.3% to 4% Sb is used to harden the bullets.

Measurement of Sb in bullets in crime,  
identifies the manufacturer.



## Applications: ...

6. Trace element content in hair material:  
Useful to characterize a person in forensic  
Identification.

7. Na content in fingernails:  
Helps in early diagnosis of cystic fibrosis in  
Children.







# Applications: ...

8. Trace element contents in blood:

10 major elements of a human

O, C, H, N, Ca, O, K, S, Na, Cl.

2 essential trace elements : Mg, Fe

7 known essential sub trace elements:

Zn, Cu, Mn, Mo, I, Co, Sc

.....

# Applications: ...

## 9. Bromine content in food stuffs

$\text{CH}_3\text{Br}$  is a pesticide. Br is a pesticide residue.

$^{81}\text{Br}$  (n, $\gamma$ )  $^{82}\text{Br}$  (0.554MeV;35.34 h T1/2)

0.1 ppm to 10 ppm

## 10. Mercury content in food stuff.

Mercury is a toxic element in food stuff, with designated zero-tolerance.

$^{196}\text{Hg}$ (n, $\gamma$ )  $^{197}\text{Hg}$ (77.6 keV; 65h T1/2)

0.05 ppm



# Applications: ...

11. Coding Elements In many areas of interest, like counterfeiting, crime investigation, etc., there is a need to identify unambiguously but subtly. Determine base level – and then add a coding element.



# Applications: ...

12. Trace element geochemistry of rocks, minerals and ores – Earth Sciences

13. Trace element environmental geochemistry – Environmental Sciences



# Neutron Activation Analysis

- Thermal
- Epithermal
- Fast
- Prompt Gamma
- Delayed Neutron
- Instrumental Neutron Activation Analysis (INAA)
- Radiochemical Neutron Activation Analysis (RNAA)



# Reference

The current status of neutron activation analysis applications, pages 679-697,  
V. P. Guinn,  
Modern Trends in Activation Analysis,  
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# Further References

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- International Conference on Modern Trends in Activation Analysis (1968 : National Bureau of Standards)  
Modern trends in activation analysis; proceedings. James R. DeVoe, editor. Philip D. LaFleur, assistant editor.  
Washington, U.S. National Bureau of Standards; for sale by the Supt. of Docs., U.S. Print. Off., 1969.



# Further References

- Methods and Applications of Radioanalytical Chemistry – MARC series

The MARC conference series' most recent conference was MARC VI held in 2003 held in Kailua-Kona. Previous conferences were held in 1987, 1991, 1994, 1997, and 2000 respectively.

- Marc VI

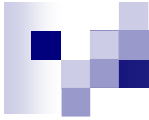
[http://www.min.uc.edu/nuclear/marc/pdf/contents\\_v01\\_marcvi.pdf](http://www.min.uc.edu/nuclear/marc/pdf/contents_v01_marcvi.pdf)





# Course Assignment

- Do literature survey, write a report and present in the class.
- Outline
  - Introduction
  - Principles
  - Instrumentation (Methodology)
  - Application
  - Provide references (text books, journals, ...)



# Session 2 End